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EDUCATION, EFFICIENCY AND ECONOMY, WITH SPECIAL  
REFERENCE TO MINING

BY LANCASTER D. BURLING

CANADIAN GEOLOGICAL SURVEY

WE have all had an education, whether we got it within natural or artificial walls, as a measure of growth with our growth in the rough and ready school or in doses identical with the other members of a class in the school whose courses are served to some according to prescribed formulæ, to others as a table d'hôte meal, from which they can "elect" the things they want. Unless our education has received a "continental" finish, however, we have never had the opportunity of tasting the courses on the intellectual menu before we ordered.

Academic reform was a topic of the day during the years immediately preceding the fall of 1914. In the present days of stress it is a vital problem, for economy has now become a necessity, true economy is impossible without efficiency, and efficiency is a matter of education. Since any economy or efficiency which ignored our second ranking industry would be farcical, mining education has become and must continue to be an object of primary concern.

After previous wars, and with less of economic necessity, the world has forgotten; after this war necessity and the operation of that universal law which ever tends to minimize external friction will soon tear down reprisal barriers, unless, indeed, the better sense of nations fails to raise them, but a long period of adjustment must succeed the final restoration of international comity. That economic necessity will weigh upon the world with a vigor previously unsurpassed is indicated by the words of Mr. Asquith at the beginning of the year 1916:

The nation's liabilities have already reached a figure which staggers the imagination and will strain its resources for a generation.

It is for our educational institutions to see to it that this scourge of economic necessity shall be beneficial, for we are convinced that intelligent direction will give it this effect.

If we are to hold our own in the period of industrial rivalry that is to come we must utilize our brain power. We must realize that pure research, though carried on without regard to gain, is the best investment a nation can assume, for its returns are certain and may be incalculably great. We must realize that science leads and its discoveries can not wait on industry. The phosphorus iron ores which mean so much to central Europe lay fallow until an English chemist solved the problem of converting them into steel. The constructive and the creative must replace the imitative—prevision must replace contemplation—qualities of youth, and we are young. But we shall need the leadership of men who believe in the principle laid down by Disraeli:

Economy does not consist in the reckless reduction of estimates; on the contrary, such a course almost necessarily tends to increased expenditures. There can be no economy where there is no efficiency.

The penalty a democracy has to pay for being a democracy is the fact that the good of the majority must wait upon its will. But the progress of the race demands a minority intelligence that shall "scorn the decisions of an unjust majority," a minority intelligence in whom the better ideas shall originate and in whom there is a willingness to carry to the extent of personal sacrifice the education of the electorate.

Several million voters will have been doing for months what they were told to do. Why? Because the men who told them knew. Well, when our men of science tell us what we ought to do, let's do it. It is hard to believe that men who have taken life at the command of an officer will not vote for the conservation of life at the request of a scientist; that men who have mined trenches for the purpose of producing casualties in the enemy will need encouragement to prevent casualties in their own ranks in the mines of peace; that men who have been part and parcel of an organization which depends on the scrutiny of detail, thorough preparation and purposeful procedure will tolerate the absence of this scientific attitude in the days of peace; and that men who are physically unfit through the accidents of war will not realize the necessity of developing and conserving the physical fitness of a people. It is for us, individuals or nations, who are not participating in the baptism through which they are passing to see to it that we shall not be the ones to clog the wheels of progress. Let us realize that we shall never act for the good of all until we master the problem of acting for our own good, and that we are masters of more than our own destiny. Nations are a people in partnership and we are each responsible for our share.

The involuntary chemicalization that is going on in the body politic of the world presages a crystallization that will not be content with other things as they have been. The best brains of our educational men should be organized now for a voluntary chemicalization of our own, that we may crystallize a scheme that shall bear the acid test of the coming years, for test there will be, and the best results for education will come if this chemicalization goes on under the proper control rather than under the stress of immediate necessity. Sudden readjustments are dramatic, but quiet preparation now for what is going to happen next year, five years from now, or a generation hence, is the thing that counts. In the words of President Eliot:

Nature's patient ways shame hasty little man.

Whether or not the life work of many of our graduates is to follow closely the lines for which they may have trained the engineering which they receive should be a practical habit of thought rather than a specific fund of knowledge. The opposite viewpoint receives abundant confirma-

tion, however, in the establishment, among the universities of North America, of 85 separate and distinct degrees in engineering, 63 undergraduate and 22 postgraduate. The same tendency is to be observed in the number of courses offered to the students of our schools, but it has seldom reached the degree of absurdity obtaining in the University of Pittsburgh. Fiction pales before the truth of the following paragraph from the eighth annual report of the Carnegie Foundation:

The catalogue of the University of Pittsburgh gives the names of a dean, a professor, and three instructors who offer one hundred and fifty-six courses in geology; three of the five offer also ninety-two courses in crystallography, mineralogy and lithology, and sixty-three courses in petrography; two of these three offer also two hundred and forty-three courses in mining geology; one of these two also bears one half the burden of one hundred and sixty-two courses in ceramics; of the remaining two of the five, one bears also one half the burden of one hundred and five courses in paleontology and one also offers sixty-three in paleobotany. Together these five men announce, probably in addition to other work in other parts of the university, a grand total of seven hundred and fifty courses, one of the five, an instructor, being alone responsible for two hundred and eighty-five. Even though all of these courses were announced for a single term only, these men would each have to give from forty to seventy courses at one time, which is preposterous.

Such a condition would convert almost any one to the opinion expressed by Professor J. C. Brown, of Liverpool:

It would be far better to teach one science subject substantially and well than to teach a smattering of several.

If a defendant of our present system of technical education were to ask me then to explain the efficiency of our engineering courses, I should say that it is to be ascribed almost solely to the fact that for four years the mental powers of the student are taxed to the limit.

You hear it said: "Mining schools are here to teach mining, not to develop culture." However defensible the stand that our universities should develop culture, their present danger is one of even neutralizing the cultural effect of a student's previous training by a system of too close application to the purely technical. But it is not so much what we study as how it is taught.

Our mining schools are not aiming at the production of well-educated or particularly skilful miners, but engineers—a difference that is expressed in terms both of mental processes and methods of attack—and the number of men in training should have little to do with the number of vacant jobs. As long as mining is carried on, so long will there be a demand for trained men, and the demand will be proportional to the supply just as far as that supply is efficient. To paraphrase a sentence from Perkins' "Some Things to Think About": What we need to-day is mines managed by engineers, not by opticians or milliners who happened to get side-tracked while they were in college.

True education bridges the gap between the mechanic and the engineer, the imitative and the creative—it is a process which is successful

to the degree in which it prepares a man for the responsibilities of a citizen and can not be measured solely by his success as a mine manager. How then are we to explain the failure of the mining engineer either to assume or to be accorded his proper place in the commonwealth of civil effort? Placing the blame for such a condition upon our own indifference is unsatisfactory, because it ignores the source of that attitude and gives us no assurance that the next generation shall not be as indifferent. Graduation from our mining schools should not be possible to any man who does not appreciate the economic value of a miner, who is not a conservationist to the backbone, who does not appreciate the fact that unlike forestry and some of the other things we hear so much about, human industry has had nothing to do with the production of the heritage which he is to exploit; that it is both expendable and irreplaceable. He must be endowed not only with "superior professional efficiency," but with those qualities which will enable him to cope successfully with the larger problems of our time. We hear a great deal about making our college courses such that our graduates will be adjustable; well, being adjustable bears about the same relation to human progress that watching a baseball game does to physical development. We need men who can and will do some adjusting themselves. Mann believed that one former was worth a thousand reformers; what would have been his ratio between formers and conformers?

Where do we stand and what can we do? And let us not be concerned so much with the level of our attainment as the direction of our going.

When we are told that the miners of the United States mine five times as much coal per day as do those of Belgium, we want to know why. Is it due to efficiency or is it due to the fact that the United States miner is allowed to waste a ton and a half of coal for every three which he sends to the surface? A ton and a half for every working day of every man in an army of three quarters of a million men. Or does the Belgian waste as much?

Why can a Nova Scotian mine over three times as much coal in a day as a Belgian? Has the difference in speed any bearing on the fact that the average number killed per year per thousand employed is nearly two and one half times as great in Nova Scotia as in Belgium, or are these figures hopelessly complicated by the fact that the number killed per million tons produced is nearly the same in both countries and that the Belgian miner works forty more days in the year and is therefore exposed to danger for that much longer period of time?

Why can the Belgian miner average forty more days in the year than the Nova Scotian, or eighty more than the American? Is it because the Belgian mines are better organized, because they are not shut down by accident so frequently, because of a better adjustment between supply and demand, or what?

Why should the ratio of coal miners killed per thousand employed remain practically stationary in the United States, Belgium, France, Germany and Japan, even on the decrease in New South Wales, while the ratio in Great Britain, India, British Columbia and Nova Scotia is increasing?

When a Montana mining company can effect an annual saving of two million dollars, or the equivalent of fifty cents per ton of ore mined, by the substitution of hydroelectric power for steam (and there is plenty of coal in Montana) is there not something here to ponder over and translate into action?

When the disparity between the deaths by accident to coal miners and to those in other occupations is traceable to defects in our mine workings should we longer depend on voluntary effort?

When an efficiency expert can take a man who has been loading pig iron on to cars at the rate of twelve tons per day and make him load forty-seven tons the next day with less fatigue, should not common sense so swell the ranks of the progressive as to eliminate the economic waste of inefficiency?

Education, not instruction, is the first step in the removal of difficulties like these, but the principle of the greatest good to the greatest number and an economic necessity that will not be denied may demand that where growth is too slow, voluntary effort too half-hearted and too provincial, legal process shall enforce conscription. A coal miner can stoop, so we wait to gouge out the floors of our levels until the roof hits the back of a mule. It is time that tendency gave place to forethought and design in the conduct of our mining operations.

As a constructive program and in addition to those changes in the spirit and ideals of our educational institutions which have been suggested, I venture to enumerate the following, not with the idea that it is complete or has not already been adopted, at least in part, but that it provides a mechanism capable of immediate application and elastic enough to provide for the expansion of the future:

First, the establishment of governmental advisory scientific commissions;

Second, the establishment of governmental "foundations for the advancement of teaching";

Third, the appointment of governmental efficiency experts, consulting master-workers in the business field.

With regard to the *advisory scientific commissions*: The British Advisory Council for Scientific and Industrial Research, the National Research Council of the United States, the Commonwealth Advisory Council on Science and Industry of Australia, and the Advisory Research Council of Canada<sup>1</sup> represent the tendency of the times. The

<sup>1</sup> The expansion of this list to include the research councils of the United States, Australia and Canada will indicate the extent to which the active collabo-

members should have such scientific standing as to inspire confidence and be so free from political, sectional, social, religious and financial bias that the disinterestedness of their public service shall be unquestioned from the start. Such a commission should be ready to consider any and every serious scientific problem referred to it, but the passive function of a disburser of information at the request of others should be the least of its activities. It should watch proposed legislation and should not only inform those interested whether history has proved or scrapped the chosen method of solving the problem, but suggest that method of procedure which the accumulated experience of the world has proved best. Finally, and most important of all, it should initiate reform and suggest legislation. It should be authorized to call in the aid upon special problems, of acknowledged experts, whether they be members of the commission or not.

It should be all-embracing in its scope and national in its institution and effect, a "general staff," if you will, which shall apply to industrial armies the combined wisdom of their experts. It should include the executive heads, or their delegated representatives, of the various scientific bureaus of the government and should be the means of introducing a much-needed cooperation, not only among these organizations, but between them and the scientific world at large. In the procession of the Juggernaut the organized effort of a comparatively small body of men is often necessary to the completion of a task for which the devoted, even frenzied, effort of the multitude has proven incapable. It is evident that the very get-at-ableness of such an organization as has been outlined will insure its frequent utilization, and there can be no doubt as to the value of such a referendum upon proposed legislation.

With regard to the *foundations for the advancement of teaching*. Let us read the concluding statement of the Parliamentary Commission of Great Britain on British charities, an investigation covering more than twenty thousand charities, carried on over a period of nineteen years, and published in forty volumes:

Of all objects of charity, the highest education has proved wisest, best and most efficient . . . because in improving higher education all other good causes are most effectually aided.

Then let us ask ourselves whether governments should not undertake work comparable in many respects with that done by private initiative in the Carnegie Foundation for the Advancement of Teaching in North America. Economic necessity may decrease the number of students in our universities, it will decrease the number who can afford to continue their work past the allotted term. This postgraduate training is essential to the development of the minority intelligence of which ration of our scientific men has become something more than the tendency it was when the British Council led the way, but no further changes have been made in the text.

we have already spoken and the first expression of the desire of such a foundation to improve the cause of higher education might well take the shape of the establishment of endowed fellowships at those educational institutions competent to equip and direct research. These institutions should be the best in each country and should be selected without fear or favor. The number of fellowships assigned to each should be determined solely on the basis of facilities and the selection of candidates should be so safeguarded as to secure only men of large caliber.

A second mode of expression on the part of the foundation would be the establishment of a considerable number of what might be called traveling fellowships, open to men already in the government employ and to qualified holders of the state-endowed fellowships, for the purpose of resident work in the educational institutions of other countries that shall immediately acquaint their governments with the best thought and the latest developments in the world of science and the arts—an open service of peace instead of the secret service of war—what the Japanese have been doing for years with such telling effect.

The Carnegie Foundation is now providing pensions for the aged and incapacitated professors in the educational institutions of the first rank in Canada and the United States, and such assistance need not therefore be an immediate concern of the governmental foundations in these countries.

In extending its fellowship only to those institutions maintaining certain standards the Carnegie Foundation has been the means of measurably raising the standard of many of the universities of the United States and Canada. In another way, and perhaps it is the farther reaching, it achieves a real effectiveness through the fearless thrusting of offending schools into the pillory of print. Governmental foundations, whatever their authority, might likewise well replace dictation to the spider with education of the fly.

A third, and not the least important, field is that of educational extension, of carrying to the people the information we have kept for those enrolled in institutions.

If the Royal Commission which has been investigating the increase in the cost of living is correct in asserting that one of the main reasons for the evil which it has been investigating is the lack of efficiency in educational systems there is already an abundant field for such foundations as we have outlined. Furthermore, we shall be in possession, during the days that are to come, of the machinery necessary for the handling of any critical situation that may develop in the field of education. We believe that the activities suggested are justified by the present emergency and that their successful operation will produce tangible results. In any case, however, the method of execution must insure co-operation between the foundations and existing educational departments—not so much because this is in the best interests of the scheme



outlined as because such cooperation is essential to the development of higher education.

With regard to the *efficiency expert*: Let us look for a moment at the possible results. A private concern once paid an efficiency expert \$150,000 to introduce efficiency in its plant; in the third year under the new régime the resultant saving per year had reached \$1,500,000. A foundry in the western part of the United States regularly uses three men to charge a cupola and has continued to do this for twenty years in spite of the fact that in another foundry two men regularly charge a cupola of twice the size, a general inefficiency in the first foundry which enables the second to turn out its finished castings for less than half as much per hundred pounds. The economic pressure of a Panama Canal toll was met by the substitution of oil for coal in the engines of the "Kroonland." The increased expenditure per trip was to be \$10,000, the resultant saving per trip, in wages and increased freight carrying capacity, was \$35,000. Why did they wait for necessity to compel them to make \$25,000 per trip? And why do others now?

The magnitude of the extra charges we may be called upon to meet are incalculable at the present time, and it may be better for the world if these are large enough to dwarf accepted methods of economics, and enforce the fundamental principle of efficiency, of doing things the right way. Indeed, the means at our disposal are so vast that the world may experience a financial recovery that shall be more wonderful than that of France in the early seventies because it will be comparably rapid and more widely beneficial.

We gauge the value of the thing received by the price we pay, and if there were no penalties attached to geographical position, and if there were uniform waste or saving in production, transport, sale and use, this would be true. However, the expert worth having will demand a salary high enough to satisfy us all as to the merit of his recommendations. Our awakening will come in the familiar ring of such suggestions as a fiscal policy that will give to each no more, no less, than he produces, the sharing by the idle of the supertax which we place on the busy, and the efficient use of land at hand and already under cultivation, rather than the hard-earned conquest of remoter areas, in the obviousness of the easy ways which he points out, and in the magnitude of the sums involved. We could do it but we don't; we are going to have to and we need a leader.

Let us remember that that something which will prevent accidents and conserve life, that will prevent waste and conserve resources, that will usher in the spirit rather than the letter of reform, that will make our graduates citizens as well as members of their craft, that will place pure science in the van of industry, that will harness up our brain power, that will replace opportunism with intelligent design in our industrial operations, and that will give us that efficiency which alone spells true economy, is education.